U. S. DEPARTMENT OF COMMERCE

BUILDING MATERIALS AND STRUCTURES

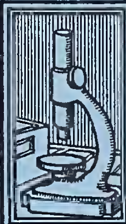
REPORT BMS38

Structural Properties of Two "Dunstone" Wall Constructions Sponsored by the W. E. Dunn Manufacturing Co.

by

HERBERT L. WHITTEMORE,
AMBROSE H. STANG, *and*
DOUGLAS E. PARSONS

NATIONAL BUREAU OF STANDARDS



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The National Bureau of Standards is a fact-finding organization; it does not "approve" any particular material or method of construction. The technical findings in this series of reports are to be construed accordingly.

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Foreword

This report is one of a series issued by the National Bureau of Standards on the structural properties of constructions intended for low-cost houses and apartments. These constructions were sponsored by industrial organizations within the building industry advocating and promoting their use. The sponsor built and submitted the specimens described in this report for participation in the program outlined in BMS2, Methods of Determining the Structural Properties of Low-Cost House Constructions. The sponsor, therefore, is responsible for the design of the constructions and for the description of the materials and of the method of fabrication. The Bureau is responsible for the method of testing and for the test results.

This report covers only the load-deformation relations and strength of the structural elements of a house when subjected to compressive, transverse, impact, concentrated, and racking loads by standardized methods simulating the loads to which the element would be subjected in actual service. It may be feasible later to determine the heat transmission at ordinary temperatures and the fire resistance of these same constructions.

The National Bureau of Standards does not "approve" a construction, nor does it express an opinion as to the merits of a construction, for the reasons given in reports BMS1 and BMS2. The technical facts presented in this series provide the basic data from which architects and engineers can determine whether a construction meets desired performance requirements.

Lyman J. Briggs, *Director.*

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CONTENTS

ABSTRACT

For the program on the determination of the structural properties of low-cost house constructions the W. E. Dunn Manufacturing Co. submitted 24 specimens representing 2 designs of their "Dunstone" constructions for walls.

The specimens were subjected to compressive, transverse, concentrated, impact, and racking loads. For each of these loads three like specimens were tested. The deformation under load and the set after the load was removed were measured for uniform increments of load, except for concentrated loads, for which the set only was determined. The results are presented in graphs and in a table.

I. INTRODUCTION

In order to provide technical facts on the performance of constructions which might be used in low-cost houses, to discover promising new constructions, and ultimately to determine the properties necessary for acceptable performance in actual service, the National Bureau of Standards has invited the cooperation of the building industry in a program of research on building materials and structures suitable for low-cost houses and apartments. The objectives of this program are described in report BMS1, Research on Building Materials and Structures for Use in Low-Cost Housing, and that part of the program relating to structural properties in report BMS2, Methods of Determining the Structural Properties of Low-Cost House Constructions.

Masonry constructions and wood constructions of types which have been extensively used in this country for houses were included in the program because their behavior under widely different service conditions is known to builders and the public. The reports on these constructions are BMS5, Structural Properties of Six Masonry Wall Constructions, and BMS25, Structural Properties of Conventional Wood-Frame Constructions for Walls, Partitions, Floors, and Roofs. The masonry specimens were built by the Masonry Construction Section of this Bureau, and the wood-frame specimens were built and tested by the Forest Products Laboratory at Madison, Wis.

The present report describes the structural properties of two wall constructions sponsored by one of the manufacturers in the building industry. The specimens were subjected to compressive, transverse, concentrated, impact, and racking loads, simulating loads to which the walls of a house are subjected. In actual service, compressive loads on a wall are produced by the weight of the roof, second floor and second-story walls if any, furniture and occupants, and snow and wind loads on the roof. Transverse loads on a wall are produced

by the wind, concentrated and impact loads by furniture or accidental contact with heavy objects, and racking loads by the action of the wind on adjoining walls.

The deformation and set under each increment of load were measured, because the suitability of a wall construction depends in part on its resistance to deformation under load and whether it returns to its original size and shape when the load is removed.

II. SPONSOR AND PRODUCT

The specimens were submitted by the W. E. Dunn Manufacturing Co., Holland, Mich., and represented two wall constructions sponsored by this company and marketed under the trade name "Dunstone." The "Dunstone" concrete blocks were made under franchise by the Silver Hill Brick Corporation, Washington, D. C. The blocks were laid to form a hollow wall. The specimens were built with cement-lime mortar.

III. SPECIMENS AND TESTS

The concrete blocks used as headers, which tied the two faces of the wall together, were vertical for one construction and horizontal for the other. The wall construction with vertical headers was assigned the symbol *CF;* the construction with horizontal headers, the symbol *CG;* and the specimens were assigned the designations given in table 1.

TABLE 1.—*Specimen designations, walls CF and CG*

Specimen designation	Load	Load applied
C1, C2, C3	Compressive	Upper end.
T1, T2, T3	Transverse	Either face.
P1, P2, P3 [a]	Concentrated	Do.
I1, I2, I3	Impact	Do.
R1, R2, R3	Racking	Near upper end.

[a] These specimens were undamaged portions of the transverse specimens.

The specimens were tested in accordance with BMS2, Methods of Determining the Structural Properties of Low-Cost House Constructions, which also gives the requirements for the specimens and describes the presentation of the results of the tests, particularly the load-deformation graphs.

For the transverse and impact loads, only three specimens were built, because the specimens were symmetrical about a vertical plane midway between the faces; and the results for transverse and impact loads applied to one face should be identical with those obtained by applying the loads to the other face. The concentrated loads were applied to only three specimens, because the inside and outside faces of the specimens were similar.

The compressive loads were applied over the entire thickness of the walls along a line distant from one face by one-third this thickness. The shortenings and sets were measured by means of compressometers attached to the steel loading plates through which the load was applied to the specimen, not attached to the specimen as described in BMS2.

Measurements of the lateral deflections under compressive loads and deflections under transverse loads were made with a deflectometer of fixed gage length. This deflectometer consists of a light (duralumin) tubular frame having a leg at one end and a hinged plate at the other. The distance between points of support was 7 ft 6 in. A dial micrometer was attached to the deflectometer at midlength. The micrometer was graduated to 0.001 in., and the readings were recorded to the nearest tenth of a division. The deflectometer was attached to the specimen in a vertical position by clamping the hinged plate to the upper end of one face. There were two deflectometers on each specimen, one near each edge. This method of measurement was used instead of the taut-wire and mirror-scale method, as described in BMS2.

The deformations under racking loads were measured by a dial micrometer which was fastened to one end of a rigid right angle built up with a steel channel and a steel angle braced to form a rigid connection. In use, this deformeter was attached to the specimen by resting the channel along the top of the specimen. Two pins driven through this channel into the top of the specimen prevented relative motion between them. The steel angle was then in a suspended vertical position in the plane of the specimen with the dial at its lowest point and the spindle of the dial bearing directly on the specimen. This deformeter was used instead of the system of taut wires and mirror scales, as described in BMS2.

The tests were begun March 6, 1939, and completed March 20, 1939. The specimens were tested 28 days after they were built. The sponsor was notified when the tests would be started but found it impossible to have a representative present.

IV. WALL *CF*

1. Description

(a) *Four-Foot Wall Specimens*

The 4-ft wall specimens with vertical headers were 8 ft 5¼ in. high, 4 ft 2¼ in. wide, and 8⅛ in. thick, and had 12 courses of blocks. The blocks formed an all-rolok in Flemish bond wall, as shown in figure 1. Each course consisted of 1-core blocks, *A*, and 3-core blocks, *B*, as stretchers with 2-core blocks, *C*, as bonding headers. The details of the blocks are shown in figures 2 and 3. The bed joints and head joints were completely filled with mortar and were cut flush with the surface of the wall.

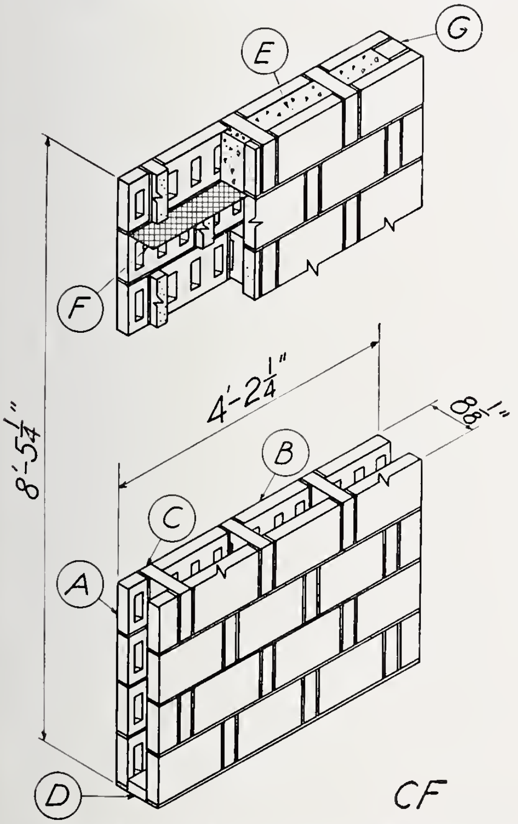

Figure 1.—*Four-foot wall specimen CF.*

A, 1-core block as stretcher; *B*, 3-core block as stretcher; *C*, 2-core block as bonding header; *D*, mortar 2 in. thick; *E*, concrete fill; *F*, expanded metal; *G*, 1-core block for end of concrete form.

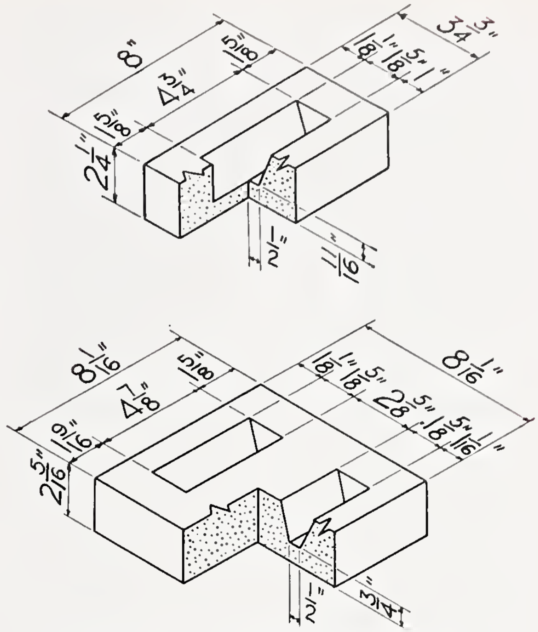

Figure 2.—"*Dunstone*" *concrete blocks.*

1-core and 2-core blocks.

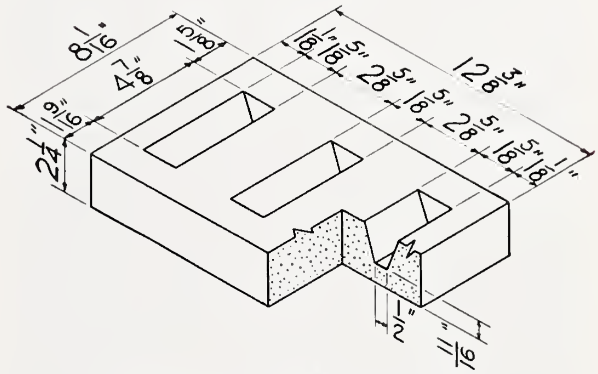

Figure 3.—"*Dunstone*" *concrete block.*

3-core block.

The space between the blocks of the first course was filled with mortar, *D*, to a height of about 2 in. above the bottom of the wall to support the first course during construction. The top course was filled with concrete, *E*. The bottom form for the concrete was made by placing a length of expanded-metal corner bead, hammered flat, *F*, in the bed joint and filling the openings in the expanded metal with mortar. Two 1-core blocks, *G*, laid in the space between the blocks of the top course served as the end forms for the concrete. The concrete was poured on the day following the completion of the specimen.

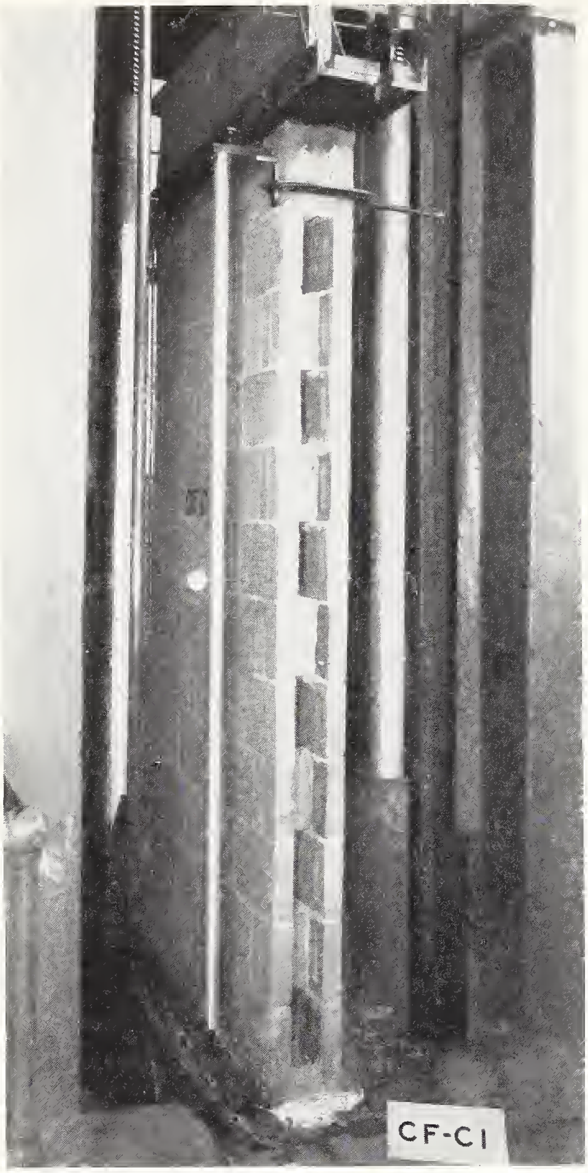

FIGURE 4.—*Wall specimen CF–C1 under compressive load.*

The price of this construction in Washington, D. C., as of July 1937, was \$0.20/ft^2.

Concrete blocks.—The materials for the blocks were portland cement and washed bank sand (passed ¼-in. sieve). The blocks were made by the Silver Hill Brick Corporation in the proportions of 8 parts of sand to 1 part of portland cement by volume. The blocks were made on a standard Dunbrik-Dunstone machine manufactured by the W. E. Dunn Manufacturing Co.

The physical properties of the concrete blocks, determined by the Masonry Construction Section of the National Bureau of Standards, in accordance with the ASTM Standard C 90–36,[1] are given in table 2.

TABLE 2.—*Physical properties of the concrete blocks, walls CF and CG*

Block	Compressive strength,[a] gross area	Water absorption, 24-hr cold immersion		Dry weight	
		By weight	Per cubic foot of concrete	Per block	Per cubic foot of concrete
	lb/in.²	*Percent*	*lb*	*lb*	*lb*
1-core	1, 330	11. 0	12. 7	3. 81	116
2-core	2, 060	6. 2	9. 3	9. 78	129
3-core	1, 730	7. 4	9. 7	13. 90	125

[a] Load applied in direction of longer dimension of core.

Mortar.—The materials for the mortar were Medusa Cement Co.'s "Medusa" portland cement, lime putty made by slaking Standard Lime and Stone Co.'s "Washington" powdered quicklime, and Potomac River building sand.

The mortar was 1 part of cement, 0.42 part of hydrated lime, and 5.1 parts of dry sand, by weight. The proportions by volume were 1 part of cement, 1 part of hydrated lime, and 6 parts of loose damp sand; assuming that portland cement weighs 94 lb/ft^3, dry hydrated lime 40 lb/ft^3, and that 80 lb of dry sand is equivalent to 1 ft^3 of loose damp sand. The materials for each batch were measured by weight and mixed for not less than 2 minutes in a batch mixer having a capacity of ⅔ ft^3. The amount of water added to the mortar was adjusted to the satisfaction of the mason.

The following properties of the mortar materials and of the mortar and concrete were determined by the Masonry Construction Section. The cement complied with the requirements of Federal Specification SS–C–191a, Cement; Portland, for fineness, soundness, time of setting, and tensile strength. The lime putty contained 40 to 45 percent of dry hydrate, by weight, and had a plasticity of over 600, measured in accordance with Federal Specification SS–L–351, Lime; Hydrated (for) Structural Purposes. The sieve analysis of the sand in the mortar is given in table 3.

[1] ASTM Standards, pt. 2, 168–171 (1936).

Table 3.—*Sieve analysis of the sand in mortar, walls CF and CG*

U. S. Standard Sieve number	Passing, by weight
	Percent
8	100
16	98
30	81
50	23
100	3

The average water content of the mortar was 23.9 percent by weight of the dry materials. Samples were taken from at least one batch of mortar for each wall specimen, the flow determined in accordance with Federal Specification SS–C–181b, Cement; Masonry, and six 2-in. cubes made. Three cubes were stored in water at 70° F and three in air near the wall specimen. The compressive strength of each cube was determined on the day the corresponding wall specimen was tested. The physical properties of the mortar are given in table 4.

Table 4.—*Physical properties of the mortar and of the concrete, wall CF*

[The compressive strengths were determined on the day the corresponding wall specimens were tested]

Specimen	Mortar			Concrete, compressive strength
	Flow	Compressive strength		
		Air storage	Water storage	
	Percent	*lb/in.*²	*lb/in.*²	*lb/in.*²
C1	109	550	740	2, 790
C2	108	595	720	3, 970
C3	106	580	760	2, 830
T1	102	755	745	3, 250
T2	108	495	660	2, 700
T3	109	470	640	2, 700
I1	107	545	745	2, 790
I2	106	600	765	3, 970
I3	108	590	715	3, 970
	110	490	645	3, 180
R1	105	540	680	3, 180
	108	590	595	2, 380
R2	113	630	545	2, 380
	120	655	600	3, 390
R3	114	665	770	3, 390
Average	109	580	690	3, 130

Concrete.—The materials for the concrete fill in the top course of the wall were Medusa Cement Co.'s "Medusa" portland cement, Potomac River concrete sand, and Potomac River gravel (maximum size ⅜ in).

The concrete was 1 part of cement, 2.1 parts of dry sand, and 3.7 parts of dry gravel, by weight. The proportions by volume were 1 part of cement, 2.5 parts of loose damp sand, and 3.5 parts of gravel.

A 6- by 12-in. cylinder was made by the Masonry Construction Section from the concrete for each wall specimen and stored in air near the specimen. The compressive strength of each cylinder was determined on the day the corresponding wall specimen was tested. The compressive strengths of the concrete cylinders are given in table 4.

Expanded metal.—The expanded metal used for the bottom form of the concrete fill was a galvanized corner bead of expanded metal, 2½ in. on each side, hammered flat. The metal was 0.025 in. thick (No. 24 U. S. Std. Gage). The corner bead weighed 0.21 lb/ft.

(*b*) *Eight-Foot Wall Specimens*

The 8-ft wall specimens were 8 ft 5¼ in. high, 8 ft ⅝ in. wide, and 8⅛ in. thick, having 12 courses of blocks. The specimens were similar to the 4-ft wall specimens.

(*c*) *Fabrication Data*

The fabrication data, determined by the Masonry Construction Section, are given in table 5.

Table 5.—*Fabrication data, walls CF and CG*

[The values per square foot were computed, using the face area of the specimens]

Construction symbol	*CF*	*CG*
Thickness of bed joints, in	0. 37	0. 36
Thickness of head joints, in	. 40	. 39
1-core blocks, number/ft²	. 68	
2-core blocks, number/ft²	1. 02	
3-core blocks, number/ft²	2. 04	3. 08
Mortar materials:		
Cement, lb/ft²	1. 14	1. 18
Lime, dry hydrate, lb/ft²	0. 477	0. 495
Sand, dry, lb/ft²	5. 78	6. 02
Mason's time, hr/ft²	0. 073	0. 082

2. Compressive Load

Wall specimen *CF–C1* under compressive load is shown in figure 4. The results for wall specimens *CF–C1*, *C2*, and *C3* are shown in table 6 and in figures 5 and 6.

TABLE 6.—*Structural properties of "Dunstone" wall constructions CF and CG*

[Weight: Wall *CF*, 52.6 lb/ft²; wall *CG*, 54.8 lb/ft², based on the face area]

Construction symbol	Load									
	Compressive [a]		Transverse [b]		Concentrated		Impact [b]		Racking	
	Specimen	Maximum load	Specimen	Maximum load	Specimen	Maximum load	Specimen	Maximum height of drop	Specimen	Maximum load
		[c] *Kips/ft*		*lb/ft²*		*lb*		*ft*		[c] *Kips/ft*
CF	*C1*	38.9	*T1*	36.0	*P1*	[d] 1,000	*I1*	2.5	*R1*	1.81
	C2	40.2	*T2*	29.1	*P2*	[d] 1,000	*I2*	2.5	*R2*	1.93
	C3	42.7	*T3*	26.0	*P3*	[d] 1,000	*I3*	3.0	*R3*	2.28
Average		40.6		30.4		[d] 1,000		2.7		2.01
CG	*C1*	35.9	*T1*	24.0	*P1*	[d] 1,000	*I1*	2.0	*R1*	2.00
	C2	38.3	*T2*	([e])	*P2*	[d] 1,000	*I2*	2.0	*R2*	2.18
	C3	38.7	*T3*	26.0	*P3*	[d] 1,000	*I3*	2.0	*R3*	3.56
Average		37.6		25.0		[d] 1,000		2.0		2.58

[a] The compressive loads were applied 2.71 in. from one face of the specimen on wall *CF* and 2.69 in. from one face of the specimen on wall *CG*.
[b] Span 7 ft 6 in.
[c] A kip is 1,000 lb.
[d] Test discontinued. Specimen did not fail.
[e] This specimen had an initial crack.

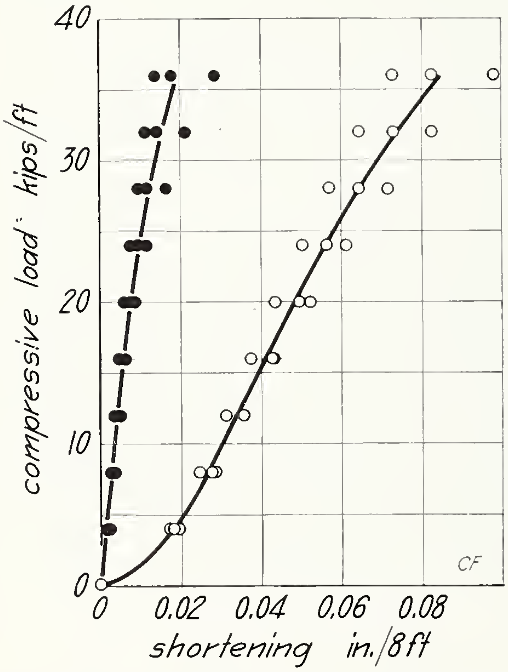

FIGURE 5.—*Compressive load on wall CF.*

Load-shortening (open circles) and load-set (solid circles) results for specimens *CF–C1*, *C2*, and *C3*. The load was applied one-third the thickness (2.71 in.) from one face. The loads are in kips per foot of actual width of specimen.

At loads of 32.0 and 39.6 kips/ft stretchers, at one edge on the face nearer the load line and near the top, cracked vertically in specimens *C1* and *C2*, respectively. Specimen *C1* collapsed at the maximum load, failing by cracking of the stretchers on the inside face near the top. Specimen *C2* failed by breaking of all the headers midway between the two faces. Specimen *C3* failed by breaking of the headers at one edge near the top.

3. TRANSVERSE LOAD

The results of the transverse load are shown in table 6 and in figure 7 for wall specimens *CF–T1*, *T2*, and *T3*.

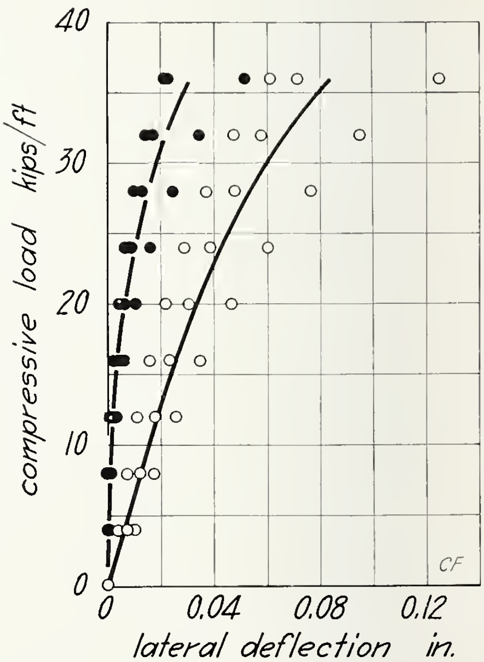

FIGURE 6.—*Compressive load on wall CF.*

Load-lateral deflection (open circles) and load-lateral set (solid circles) results for specimens *CF–C1*, *C2*, and *C3*. The load was applied one-third the thickness (2.71 in.) from one face. The loads are in kips per foot of actual width of specimen. The deflections and sets are for a gage length of 7 ft 6 in., the gage length of the deflectometers.

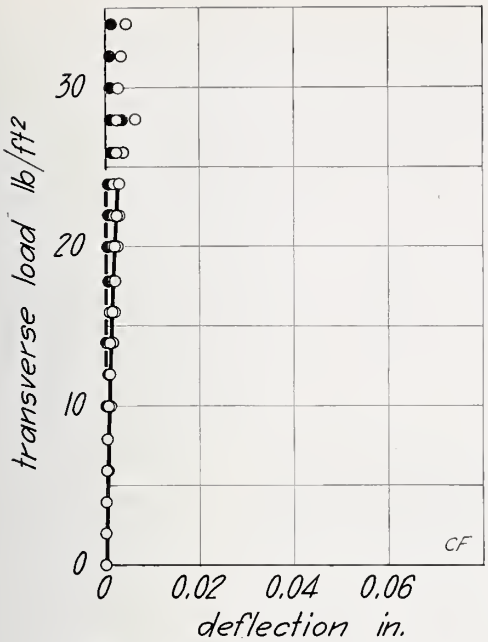

FIGURE 7.—*Transverse load on wall CF.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *CF–T1*, *T2*, and *T3* on the span 7 ft 6 in. The deflections and sets are for a gage length of 7 ft 6 in., the gage length of the deflectometers.

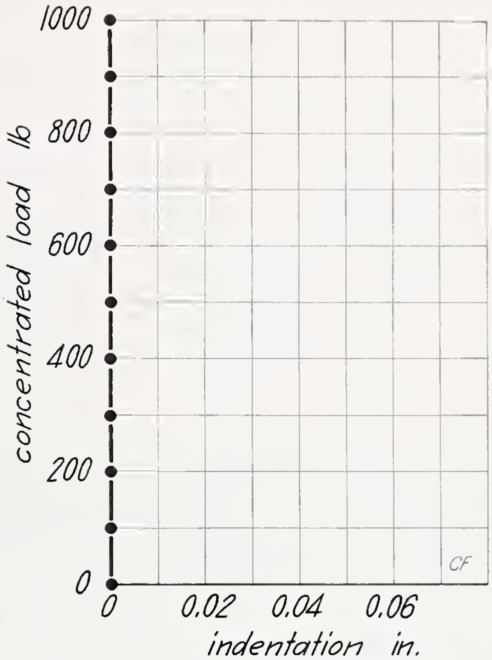

FIGURE 8.—*Concentrated load on wall CF.*

Load-indentation results for specimens *CF–P1*, *P2*, and *P3*.

Each of the specimens *T1*, *T2*, and *T3* failed by rupture of the bond between the mortar and the concrete blocks at a bed joint between loading rollers.

4. Concentrated Load

The results of the concentrated load on wall specimens *CF–P1*, *P2*, and *P3* are shown in table 6 and in figure 8.

Wall specimens *CF–P1*, *P2*, and *P3*, loaded on a stretcher block near the center of the wall, showed no measurable indentation after a load of 1,000 lb had been applied and released.

5. Impact Load

The results of the impact load on wall specimens *CF–I1*, *I2*, and *I3* are shown in table 6 and in figure 9.

In each of the specimens *I1*, *I2*, and *I3* a bond crack appeared in a bed joint near midspan on the face not struck at a height of drop of 1.5 ft. In each case failure occurred at this bond crack, which extended to the face struck.

Wall specimen *CF–I1* during the impact test is shown in figure 10.

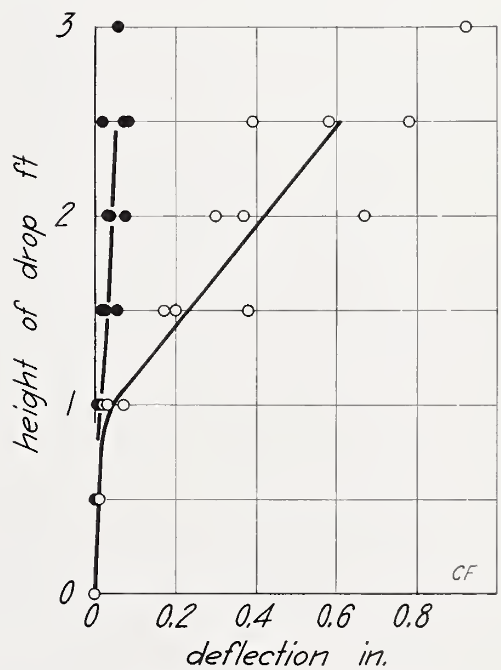

FIGURE 9.—*Impact load on wall CF.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *CF–I1*, *I2*, and *I3* on the span 7 ft 6 in.

6. Racking Load

The results of the racking load on wall specimens *CF–R1*, *R2*, and *R3* are shown in table 6 and in figure 11.

The deformations and sets shown in figure 11 were computed from the deformeter readings. The gage length of the deformeters was 7 ft 2 in.

Stepwise cracks through the bed and head joints appeared in specimens *R1* and *R2* at a load of 1.5 kips/ft and in *R3* at a load of 1.2 kips/ft. Each of the specimens failed by rupture of the cracked bed and head joints approximately along a diagonal between the point of application of the load and the stop.

V. WALL *CG*

1. Description

(a) Four-Foot Wall Specimens

The 4-ft wall specimens with horizontal headers were 8 ft 3¾ in. high, 4 ft 2¾ in. wide, and 8¹⁄₁₆ in. thick, and had 18 courses of blocks. The blocks formed an all-rolok wall, every other course being a header course with the

Figure 10.—*Wall specimen CF–11 during the impact test.*

blocks laid flat, as shown in figure 12. Three-core blocks (shown in fig. 3) laid on edge, *A*, were used in the stretcher courses and the same size blocks laid flat, *B*, were used in the header courses. Blocks, *C*, 1½-core, were used to stagger the head joints. The bed joints and the

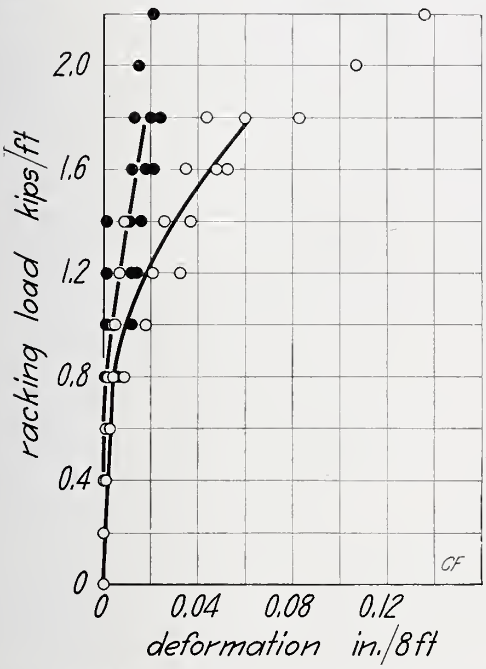

FIGURE 11.—*Racking load on wall CF.*

Load-deformation (open circles) and load-set (solid circles) results for specimens *CF–R1*, *R2*, and *R3*. The loads are in kips per foot of actual width of specimen.

head joints were completely filled with mortar and were cut flush with the surface of the wall. After the first course was laid, about 2 in. of mortar, *D*, was spread in the cavity to support the blocks laterally. The uppermost stretcher course was filled with concrete, *E*. A 1-core block, *F* (shown in fig. 2), laid inside this course, served as the end form for the concrete. The top header course was placed after the concrete was poured.

The price of this construction in Washington, D. C., as of July 1937, was $0.20/ft².

The concrete blocks, the mortar, and the concrete fill had the same proportions in wall *CG* as in wall *CF* and were made, sampled, and tested using the same methods.

For wall *CG* the average water content of the mortar was 24.0 percent by weight of the dry materials. The physical properties of the mortar and of the concrete are given in table 7.

TABLE 7.—*Physical properties of the mortar and of the concrete, wall CG*

[The compressive strengths were determined on the day the corresponding wall specimens were tested]

Specimen	Mortar			Concrete, compressive strength
	Flow	Compressive strength		
		Air storage	Water storage	
	Percent	*lb/in.²*	*lb/in.²*	*lb/in.²*
C1	109	555	715	3,390
C2	108	530	750	4,020
C3	107	680	710	4,110
T1	108	470	730	4,020
T2	107	600	730	3,540
T3	108	585	665	3,250
I1	108	525	740	2,830
I2	108	570	715	3,390
I3	106	610	765	4,020
R1	108	585	705	3,290
	116	495	630	3,290
R2	114	590	700	3,330
	112	550	700	3,330
R3	113	490	675	3,180
	114	555	720	3,180
Average	109	560	710	3,480

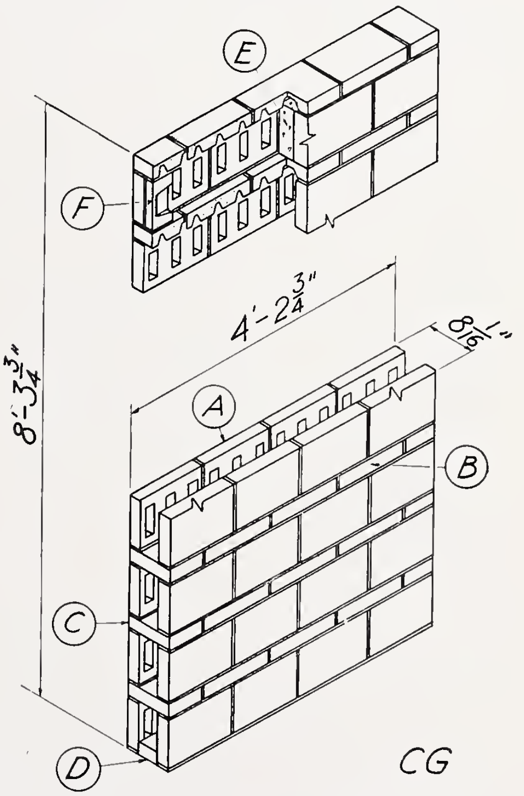

FIGURE 12.—*Four-foot wall specimen CG.*

A, 3-core block as stretcher; *B*, 3-core block as header; *C*, 1½-core block; *D*, mortar 2 in. thick; *E*, concrete fill; *F*, 1-core block for end of concrete form.

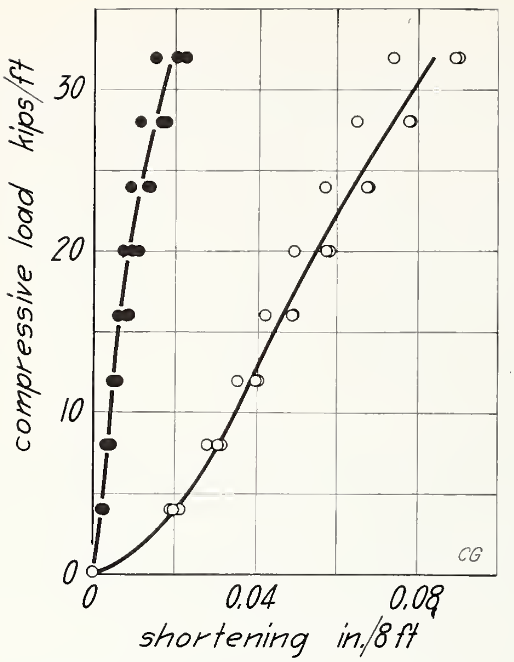

FIGURE 13.—*Compressive load on wall CG.*

Load-shortening (open circles) and load-set (solid circles) results for specimens *CG–C1*, *C2*, and *C3*. The loads were applied one-third the thickness (2.69 in.) from one face. The loads are in kips per foot of actual width of specimen.

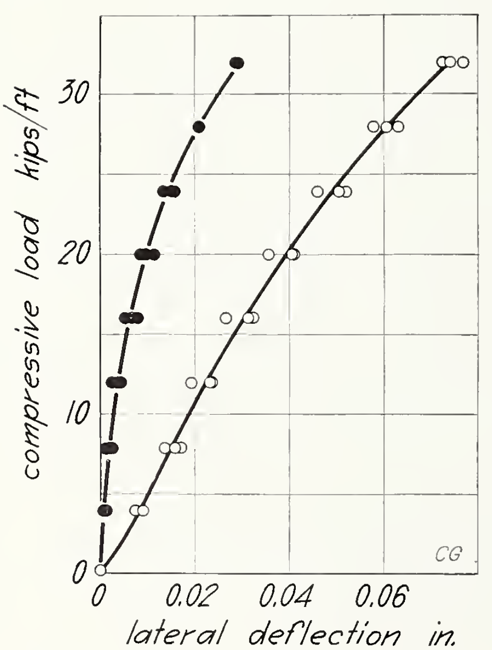

FIGURE 14.—*Compressive load on wall CG.*

Load-lateral deflection (open circles) and load-lateral set (solid circles) results for specimens *CG–C1*, *C2*, and *C3*. The load was applied one-third the thickness (2.69 in.) from one face. The loads are in kips per foot of actual width of specimen. The deflections and sets are for a gage length of 7 ft 6 in., the gage length of the deflectometers.

(*b*) *Eight-Foot Wall Specimens*

The 8-ft wall specimens were 8 ft 3¾ in. high, 8 ft 5½ in. wide, and 8⁵⁄₁₆ in. thick. The specimens were similar to the 4-ft wall specimens.

(*c*) *Fabrication Data*

The fabrication data, determined by the Masonry Construction Section, are given in table 5.

2. COMPRESSIVE LOAD

The results of the compressive load on wall specimens *CG–C1*. *C2*, and *C3* are shown in table 6 and in figures 13 and 14.

In specimen *C1*, a block on the face nearer the load line at one end near midheight crushed at a load of 34.5 kips/ft. Failure occurred by the crushing of blocks and mortar in the two adjacent courses on the face nearer the load line and near midheight. Specimens *C2* and *C3* failed by breaking of the headers at the inner surfaces of both faces, each header breaking in two places. Specimen *C2*, at the maximum load, collapsed suddenly without warning.

3. TRANSVERSE LOAD

Wall specimen *CG–T2* under transverse load is shown in figure 15.

The results of the transverse load on wall specimens *CG–T1*, *T2*, and *T3* are shown in table 6 and in figure 16.

After specimen *T2* had been set in place for the transverse test, but before a load had been applied, it was noticed that a bond crack in the bed joint below the fourteenth course existed in both faces. This crack was probably caused by moving the specimen into position for testing. The maximum load on specimen *T2* was 10.3 lb/ft^2, at which load the initial crack widened.

In specimen *T3*, a crack in the bond between the mortar and the blocks at a bed joint appeared at a load of 20 lb/ft^2.

At the maximum loads each of the specimens *T1*, *T2*, and *T3* failed by rupture of the bond between the mortar and the blocks at a bed joint.

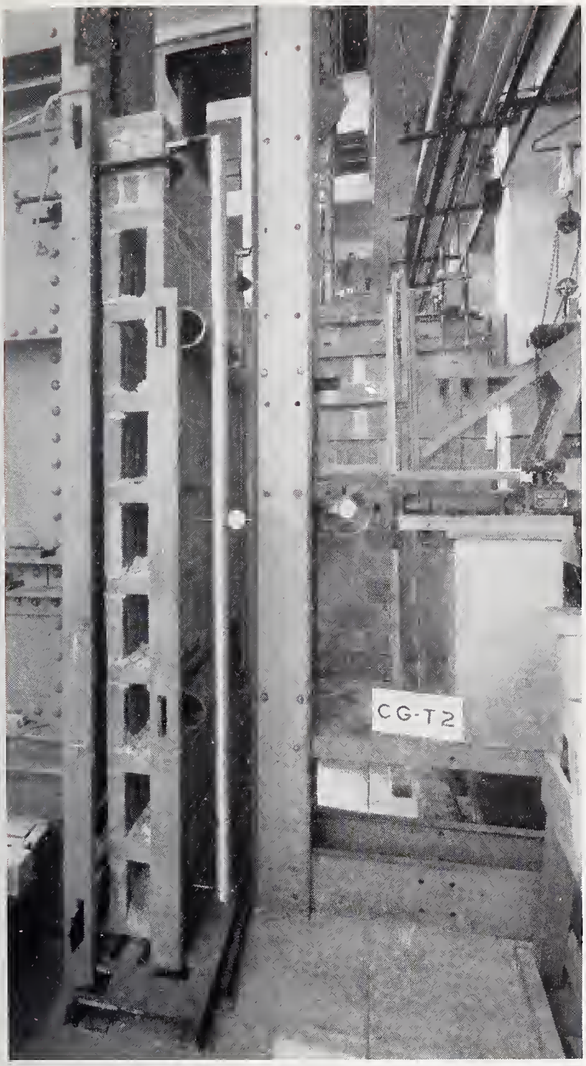

FIGURE 15.—*Wall specimen CG–T2 under transverse load.*

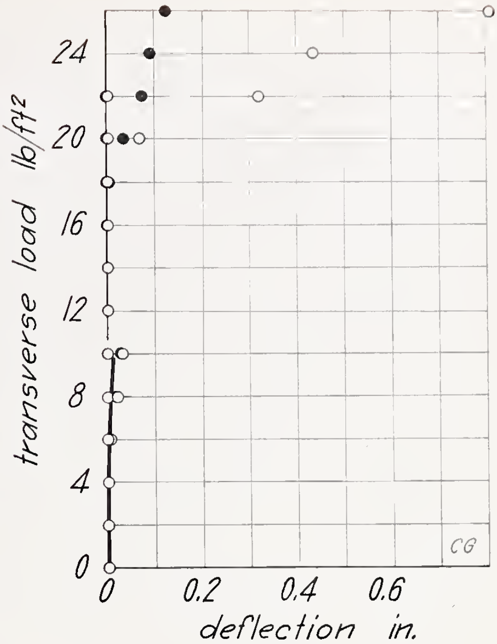

FIGURE 16.—*Transverse load on wall CG.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *CG–T1*, *T2*, and *T3* on the span 7 ft 6 in. The deflections and sets are for a gage length of 7 ft 6 in., the gage length of the deflectometers.

4. CONCENTRATED LOAD

The results of the concentrated load on wall specimens *CG–P1*, *P2*, and *P3* are shown in table 6 and in figure 17.

There was no measurable indentation for any of the specimens after a load of 1,000 lb had been applied and released.

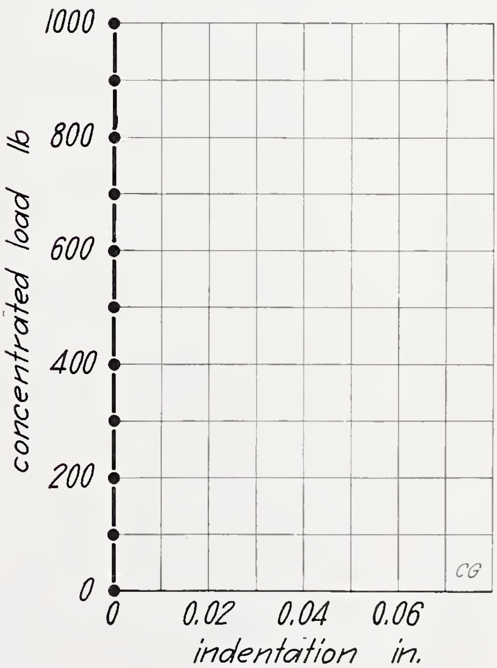

FIGURE 17.—*Concentrated load on wall CG.*

Load-indentation results for specimens *CG–P1*, *P2*, and *P3*.

5. IMPACT LOAD

The results of the impact load on wall specimens *CG–I1*, *I2*, and *I3* are shown in table 6 and in figure 18.

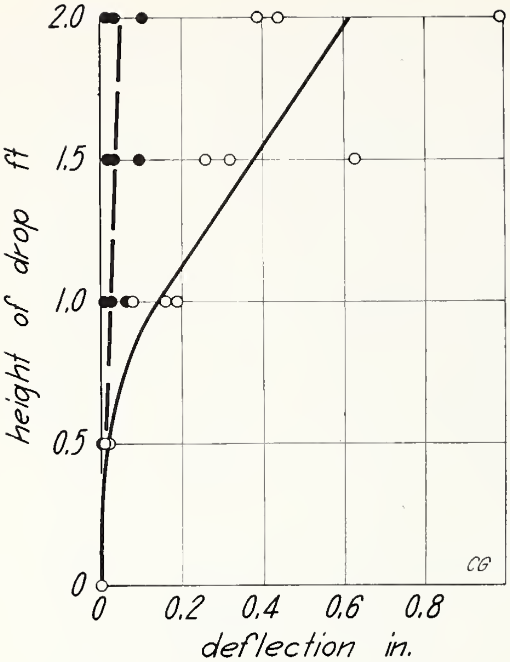

FIGURE 18.—*Impact load on wall CG.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *CG–I1*, *I2*, and *I3* on the span 7 ft 6 in.

A bond crack appeared in a bed joint near midspan on the face not struck in specimens *CG–I1*, *I2*, and *I3* at a height of drop of 1.0, 1.5, and 1.0 ft, respectively. In each case, at failure, this bond crack extended to the face struck.

6. Racking Load

Wall specimen *CG–R2* under racking load is shown in figure 19. The results for wall specimens *CG–R1*, *R2*, and *R3* are shown in table 6 and in figure 20.

The deformations and sets shown in figure 20 were computed from the deformeter readings. The gage length of the deformeters was 6 ft 7 in.

Each of the specimens failed by rupture of the bed and head joints in stepwise cracks approximately along a diagonal between the point of application of load and the stop. In addition, in each case the concrete blocks at the toe cracked diagonally at the maximum load.

FIGURE 19.—*Wall specimen CG–R2 under racking load.*

VI. SPONSOR'S COMMENTS

Reinforced-concrete pilasters or columns are formed in the space between the facing and backing by inserting stops at the desired location and placing reinforcing steel and concrete

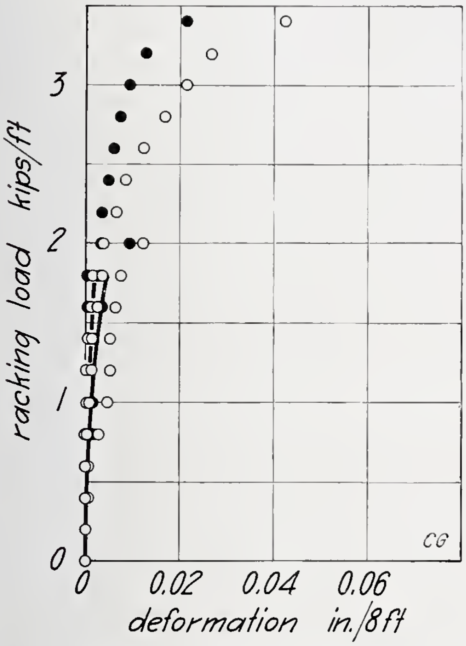

FIGURE 20.—*Racking load on wall CG.*

Load-deformation (open circles) and load-set (solid circles) results for specimens *CG-R1, R2*, and *R3*. The loads are in kips per foot of actual width of specimen.

in the enclosed space. Beams and lintels are also reinforced concrete, formed in the same manner.

The outside of the wall may be finished with cement paint or may be stuccoed. The inside of the wall may be finished with plaster, consisting of a ½-in. base coat applied directly to the blocks and covered by the usual white finish. The total cost of these constructions in Washington, D. C., as of July 1937, when weatherproofed with cement paint and plastered on the inside, is \$0.36/ft^2.

The "Dunstone" blocks are manufactured by 96 individually owned plants in different parts of the country. There are no standardized mixes for the blocks due to the use of local materials. Each plant has tests made by the local testing laboratories to insure compliance with the requirements of the sponsor and of the building codes of different cities.

Many other sizes of "Dunstone" blocks than the three sizes mentioned in this report are available. They may be obtained in a wide range of colors, shades, and textures, offering a permanent colored exterior for the building.

The "Dunstone" blocks may be used for other types of walls than the two described in this report and for veneering frame constructions.

The drawings of the specimens were prepared by E. J. Schell and G. W. Shaw, of the Bureau's Building Practice and Specifications Section, under the supervision of V. B. Phelan.

The structural properties were determined by the Engineering Mechanics Section, under the supervision of H. L. Whittemore and A. H. Stang, and the Masonry Construction Section, under the supervision of D. E. Parsons, with the assistance of the following members of the professional staff: F. Cardile, H. Dollar, M. Dubin, A. H. Easton, A. S. Endler, C. C. Fishburn, C. D. Johnson, A. B. Lanham, P. H. Petersen, A. J. Sussman, and L. R. Sweetman.

WASHINGTON, August 5, 1939.

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